LIII.—*On* Stauronella, *a new Genus of Diatoms.*

By C. Mereschkowsky.

[Plate VIII.]

It has been shown, in my paper "On *Okedenia*" *, what important results can be obtained if the study of diatoms is not confined to their dead shells alone, but if living specimens, and especially their endochrome, are also taken into consideration. It is there shown that a form generally thought to be a *Navicula* is not a *Navicula* at all, that a species referred to *Amphora* did not belong to that genus, and that both had to be united in a separate genus—*Okedenia*; also how easy it was to distinguish some of the species of this genus on account of their endochrome, which otherwise could hardly be distinguished even as varieties.

In the present note we have another example of the same kind. A diatom which is generally believed to belong to the genus *Navicula*, or to its section *Stauroneis*, proves, on account of its endochrome, not only not to belong to that genus, nor even to the family Naviculaceæ, but not to have any relation whatever to the whole tribe of the Naviculoid diatoms.

The diatom to which I refer is the so-called *Stauroneis constricta*, Ehr. It was first introduced into science by Ehrenberg, who described it under that name in 1843 in his work on American Microgeology. But its appearance is so peculiar and so distinct from all other species of the same genus, especially when observed from the girdle-face, that it was soon removed from the genus *Stauroneis* and placed by W. Smith † in the genus *Amphiprora*, which this diatom, indeed, somewhat resembles in its girdle-face; and most diatomists continued to name it *Amphiprora constricta* until a comparatively recent date. But this last genus was no more the right place for the diatom than the former one. At the time of W. Smith (1853–1856) *Amphiprora* was not well defined, and various heterogeneous forms have been united under this name; but since Rabenhorst, Pfitzer ‡, and especially Cleve have more strictly limited it to forms with a sigmoid raphe, *Amphiprora constricta* could no longer remain there, its raphe being straight and not sigmoid;

* *Suprà*, p. 415.

† W. Smith, 'Synopsis of the Brit. Diatomaceæ,' 1853–1856.

‡ E. Pfitzer, 'Untersuchungen über Bau u. Entwicklung d. Bacillariaceen,' 1871.

and so it was again removed to the Naviculaceæ, and placed by Cleve * in the genus *Navicula*, section *Microstigmaticæ*, division or subgenus *Stauroneis*, under which name it has also recently been described by Peragallo †.

It can, however, be easily shown that this is not its proper place, that it has no real affinity to the Naviculaceæ, and that therefore this unfortunate diatom has again to be removed somewhere else. But since it cannot find a suitable home in any of the existing genera, it clearly results that it has to seek one elsewhere—in other words, it ought to form a new genus, which I propose to call *Stauronella*; and by so doing I hope all trouble with this unfortunate diatom will cease, and it will find in the new genus a well-merited rest.

As I intend to prove the necessity of constituting this new genus on account of its endochrome, we will now proceed to the description of the latter. It is, however, not on the type species that we will study the endochrome, but on a new variety (var. *linearis*, Mer.), the description of which will be given below.

The endochrome is composed of two plates, which are characterized by a very peculiar disposition, not to be found in any other species of Naviculoid ‡ diatoms. Each half of the frustule, the superior and inferior, has its own plate, both being separated in the central part of the frustule by a transverse hyaline space, *i. e.* by an interval directed along the shorter axis; both plates rest by their median part on one of the connecting-zones (fig. 19), which might be called the dorsal connecting-zone. The margins of the plates rest on the surface of both valves, covering their whole breadth (figs. 16, 17, 19). When seen from the girdle-face these margins appear as dark lateral bands on both sides of the frustule (fig. 18, *c*); the lighter part, uniting them, corresponds to the median portion, which, as already mentioned, rests on the dorsal zone. The plates are rather short, occupying only the median portion of the frustule, and never reaching its extremities; the margins are usually entire (fig. 17), sometimes more or less sinuated (fig. 16). The transverse hyaline space which separates the two plates is always distinct, rather broad, excavated in the

* P. Cleve, 'Synops. of the Navicul. Diat.' part i. p. 145.

† H. Peragallo, 'Les Diat. mar. de France, i. p. 56.

‡ I am using here the term Naviculoid not in the sense given by Cleve in his 'Synopsis of the Naviculoid Diatoms,' who uses it as a synonym of the Raphidian diatoms, but in the more restricted sense which is given to this term by Peragallo in his 'Diatomées marines de France,' p. 2.

centre, where it forms a more or less well-marked circular space, in which the nucleus is placed. The terminal ends of the plates may be straight (fig. 17) or provided with a more or less deep longitudinal sinus (fig. 16).

Each plate contains in its centre a conspicuous pyrenoid (figs. 16, 17, 19, *pr.*), composed of a refractive material, which is imbedded in the very substance of the chromatophore-plate, thus being limited on all sides by the coloured endochrome mass. It forms a hemispherical protuberance projecting into the inner space of the frustule, almost reaching its central axis (figs. 16, 17), sometimes being separated from the walls of the frustule by a hemispherical hyaline space (fig. 16). This pyrenoid is, however, only seen when the diatom presents to the observer its valve-face; as soon as it is moved to one side or the other, even in a slight degree, it immediately disappears, a peculiarity which also belongs to the pyrenoids of most species of the genus *Nitzschia*. It is obvious that no trace of pyrenoids will be seen when the diatom presents its girdle-face, as in fig. 18. In this figure the centre of each plate, *i. e.* the centre of the lighter part of it, is the real place of the pyrenoid, and there it ought to be seen had it not become invisible. Such an absence of a visible pyrenoid in the girdle-face is also a characteristic of most of the *Nitzschiæ*.

The elæoplasts are round, of a comparatively large size, variable in number, placed at the outer and inner ends of the chromatophore-plates (fig. 18). The colour of the endochrome is yellow-brown.

As above described, the endochrome of *Stauronella constricta* appears to be of a very peculiar nature. In order, however, to understand in what this peculiarity consists, and so to appreciate its whole value, I shall have to enter into some general considerations concerning the endochrome of diatoms based on my rather extensive studies on this subject.

I have carefully studied the endochrome of over three hundred forms, amongst which not less than one hundred and fifty belong to the Naviculaceæ and Nitzschieæ. As a general result of the comparison of the endochrome of these two groups, I can state that the endochrome of the Naviculaceæ is of a quite different and even diametrically opposed type to that of the Nitzschieæ. In both groups the typical number of chromatophores is two; but while in the Naviculaceæ these plates have a longitudinal disposition, *i. e.* they are placed side by side and separated by a longitudinal interval along the longer axis of the frustule, each plate

occupying the right and left side of the frustule (see diagram fig. 1), in the Nitzschieæ each plate occupies the superior and inferior half of the frustule, thus being separated not by a longitudinal but by a transverse interval along the short axis of the frustule (fig. 3 of the diagram). This arrangement may be termed transverse disposition, as opposed to the longitudinal disposition of the Naviculaceæ. Whenever there are two chromatophore-plates in the Naviculaceæ they may be distinguished, according to their position, as the right and the left,

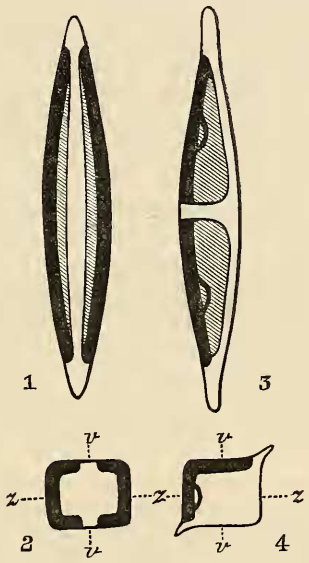

Diagram showing the typical disposition of the two chromatophore-plates in Naviculaceæ (figs. 1, 2) and Nitzschieæ (figs. 3, 4). Figs. 1 and 3, valve-view; figs. 2 and 4, transverse sections. *v*, *v*, valves; *z*, *z*, connecting-zones.

while in the Nitzschieæ when there are two plates they may be distinguished not as the right and left, but as the superior and inferior. Even in such cases as *Cylindrotheca*, *Nitzschia dissipata*, *Homœocladium Martianum*, &c., where the number of chromatophores is more than two, they form two groups—a superior and an inferior—separated by a transverse interval, instead of forming a right and left group, as is the case in *Okedenia*, where the number of chromatophores is also large.

I can positively affirm that I have not met a single case of

a transverse disposition of the chromatophores in the whole section of Naviculoid diatoms *.

If now we compare figures 16–18 of the Plate with the diagrams figs. 1 and 3, we can easily see that the endochrome of *Stauronella constricta* belongs to the *Nitzschia* type, and not to the *Navicula* type.

There is another difference between the endochrome of Naviculaceæ and Nitzschieæ. In all the former the two plates (or the two pairs of plates if there are four), if not resting on the valves, as in the Punctatæ † and Lyratæ, are applied to both connecting-zones (diagram fig. 2). In the Nitzschieæ both plates rest on one connecting-zone (with their margins resting on one or both valves), the other zone being free (diagram fig. 4), and this is exactly the position which the two chromatophores of *Stauronella constricta* occupy (Pl. VIII. fig. 19). Lastly, I could point to the conspicuous pyrenoids, which are very rare in true Naviculaceæ (except in such genera as *Cymbella*, *Gomphonema*, &c., which are provided with pyrenoids) and very common amongst the Nitzschieæ.

It is only when all these various facts are taken into account that the peculiar structure of the endochrome of *Stauronella constricta* acquires all its importance. This species is most assuredly not a Naviculoid diatom, its endochrome being of the type characteristic of the Nitzschieæ.

But what is it, then? Does it belong to the Nitzschieæ?

* It may be objected that in *Mastogloia*, in which, according to Cleve (Syn. Navic. Diat. part ii. p. 142), there are only two plates, these latter have the same transverse disposition as in *Nitzschia*, with a line of separation along the short axis of the frustule; but in reality this is not so. My observations on the endochrome of *Mastogloia* have shown that this genus has four plates, and not two, as stated by Cleve; two of these plates belong to the right side of the frustule and two to its left side, both pairs being separated by a longitudinal interval. We have therefore in *Mastogloia* the same disposition as in *Navicula*, only with the difference that each plate is divided transversely, thus forming in all four plates. Some other genera characterized by the presence of four plates (*Scoliotropis* [Cleve], *Neidium*, *Tropidoneis*, *Pleurosigma*, *Toxonidea* [Mereschkowsky]) are similarly placed. Although in all these cases there exists, as in *Nitzschia*, a transverse separation in the middle of each plate, dividing them in two plates (superior and inferior), yet at the same time both pairs of one side of the frustule are separated from the pair of the opposite side by a longitudinal interval. So that in reality the four plates of all these genera (including *Mastogloia*) have the same disposition as the two plates of *Navicula*, the right plate of *Navicula* being represented by a right pair of plates and its left plate by a left pair.

† I have found the endochrome of the Punctatæ to be of the same kind as that of the Lyratæ.

By no means. The structure of the frustule is opposed to such a conclusion. And, further, there are other groups of the Raphidian diatoms which are equally characterized by a transverse disposition of their two chromatophore-plates. Such is the case, for instance, with certain *Amphiprorœ*. It is generally admitted that *Amphiprora* has a single chromatophore *; but here, again, my researches have shown that this is not quite so. It is true that *A. paludosa* has a single chromatophore-plate, but in several other species I have found two plates—a superior and an inferior—separated in the middle by a transverse interval, exactly as in *Nitzschia*. *Stauronella constricta* cannot, however, as already mentioned, take its place in the genus *Amphiprora*, its raphe being straight and not sigmoid as in that genus. We come therefore to the inevitable conclusion that this diatom belongs to a new genus—*Stauronella*—nearly allied to *Amphiprora*, and forming with the latter a transitional group between the Raphideæ and Carinatæ †. It represents, in my opinion, a remnant of a very old, now almost extinct, group of diatoms, which I propose to call **Archaideæ**. This is a central group from which have sprung on one side the Raphidian Diatoms and on the other the Carinatæ (Nitzschicæ, Surirelloideæ). As remnants of this group or as living representatives of the Archaideæ I consider the genera *Stauronella*, *Amphiprora*, *Amphoropsis* ‡, *Auricula*, and *Epithemia*. This theory will be explained more completely in a paper now in course of publication.

* Cleve, Syn. of the Navic. Diat. part i. p. 13.

† In my paper "Sur la Classification des Diatomées" (Scripta Botanica, St. Petersburg, fasc. xviii.) I have established a new system of classification of the Diatoms, in which I divide them first in two groups—the Mobiles, provided with a slit or a series of holes in the walls of the frustule, and therefore being endowed with movement; and the Immobiles, without such a structure, and therefore unmovable. The Mobiles are again divided in two groups—the Raphidieæ in the generally accepted sense, and the Carinatæ, comprising the Nitzschioideæ and Surirelloideæ. The Immobile diatoms are also divided in two groups—the Bacilloideæ, including the Pseudoraphidieæ with the exclusion of the Carinatæ; and the Anaraphidieæ in its old acceptance. I hope that this system, which has the advantage of doing away with the highly artificial group Pseudoraphidieæ, will be generally accepted by diatomists as being at the same time simple and very natural.

‡ Under the name of *Amphoropsis* I unite forms with a straight raphe elevated on a keel turned in the same direction, with asymmetrical valves and with two chromatophores disposed transversely, or with granules. The following species belong to this genus:—*A. recta* (*Tropidoneis recta*), *A. conserta* (*Trop. conserta*), *A. pontica*, sp. n., *A. stauroneis*, Mer., and probably *A. Van Heurckii* (*Trop. Van Heurckii*).

The diagnosis of the genus *Stauronella* is as follows:—

STAURONELLA, Mer.

Valve narrow, linear or attenuated towards the ends, usually constricted in the middle; extremities truncate or rounded, rarely cuneate. Raphe straight, symmetric; central nodule elongated transversely in a stauros. Girdle-face constricted, zone complex. Endochrome composed of two plates disposed transversely along one of the connecting-zones; each plate with a conspicuous pyrenoid.

Contains one species, *S. constricta* (Ehr.), Mer., with several varieties.

This diatom has not yet been sufficiently well described, and the figures, especially those of the girdle-face, are very unsatisfactory. I will therefore give here a good description of it, accompanied by figures, and then pass to the consideration of a new variety.

Stauronella constricta (Ehr.), Mer.
(Pl. VIII. figs. 1–6.)

Stauroneis constricta, Ehrenberg, Amer. pl. i. 2, fig. 12 *b*; Peragallo, Diatomées mar. d. France, p. 56, pl. vii. figs. 32, 33. *Stauroneis* (*Libellus*) *constricta* (Ehr.?), W. Sm., Cleve, Syn. Navic. Diat. part i. p. 145 (ex parte). *Amphiprora constricta*, W. Smith, Brit. Diat. i. pl. xv. fig. 126*. *Stauroneis amphoroides*, Grun. (ex parte), A. Schm. Atlas, xxvi. figs. 37–39.

Diagnosis.—Valve convex, narrow, linear-lanceolate, constricted in the middle, attenuated towards the extremities, which are broad, truncate. Central nodule extending transversely in a narrow stauros, reaching the margins. Striæ 25–27 in 0·01 mm. (*Cleve*), transverse. Axial area indistinct. Girdle-face narrow, constricted in the middle, where the stauros appears as a brilliant bead, narrowed towards the ends. Zone complex. Length 0·021–0·056 mm. (average 0·04 mm.); breadth of valve 0·0052–0·0081 mm.; breadth of girdle-face 0·0076–0·0105 mm., at the constriction 0·0057–0·0086 mm.

Locality. North Sea (*Cl.*)?; Black Sea (Sebastopol, mar., *Mer.*); Mediterranean (Nice, mar., *Per.*). Fossil: Crimea, Kertch (sarmatische Stufe, mar., *Mer.*).

* Not being in possession of the work of W. Smith, I am unable to say whether this quotation which I give after Cleve is correct or not. Cleve gives also as synonym the *Navicula simulans* of Donkin (Brit. Diat. p. 60, pl. ix. fig. 3). But, as Van Heurck has shown ('A Treatise on the Diatomaceæ,' p. 235, pl. xxvii. fig. 784), this latter represents quite a different species. Whether it belongs to *Stauronella* or not cannot be decided without knowing its endochrome; it is, however, not likely to be the case, as the girdle-face does not at all resemble that of *S. constricta*.

The valve of the type species is never linear, as described by some authors, but always considerably attenuated towards the ends; the latter are invariably truncate, the middle part being more or less constricted, with a few exceptions amongst small individuals (fig. 6). The form of the valve is very constant, the only variation consisting in its greater or less breadth: fig. 5 represents a narrow form, the valve being more linear; fig. 2 is more typical.

The girdle-face is very badly reproduced by A. Schmidt (Atl. xxvi. fig. 37) as well as by Peragallo (D. m. d. Fr. pl. vii. fig. 32); both figures represent it in an oblique position, and give no idea whatever of its real appearance. This is due to the fact that the diatom under consideration has, it appears, never been studied on raw material, as it ought to be, but only on mounted specimens in slides, from which it usually disappears during the cleaning of the material. I have seen hundreds, perhaps thousands, of frustules, and fig. 1 (Pl. VIII.) represents a typical specimen of it; fig. 4 is also good. Sometimes two frustules are united by their sides, as in fig. 3, and such cases show a striking resemblance to Ehrenberg's figure *. This removes all doubt as to the identity of *Stauroneis constricta* of Ehrenberg with the form here described.

The outlines of the frustule are strong and coarse, the constriction in the middle always well marked; the stauros appears as a very bright round bead. The extremities are more (figs. 3, 4) or less (fig. 1) narrowed, the ends being roundly truncate, more distinctly truncate when the frustule is broad (fig. 4). The zone is very finely but distinctly striate in a longitudinal direction, the striæ or divisions (5–6 in number) never terminating in marginal puncta as in var. *linearis*.

I give here a series of individual measurements, which show that the size is far from being so large as stated by Cleve (0·05–0·14 mm.), who was evidently in possession of some variety.

Length.	Breadth of the frustule.	At the constriction.
mm.	mm.	mm.
0·021	....	....
0·025	0·0076	0·0057
0·0266	0·0095	0·0086
0·0266	0·0095	....
0·0285	0·0086	0·0067

* I have not seen the original figure, but only its reproduction in Wolle's 'Diat. of America.'

	Length.	Breadth of the frustule.	At the constriction.
	mm.	mm.	mm.
	0·0295	....	....
	0·0295	0·0076	0·0057
	0·042	....	....
	0·0437	0·0095	0·0067
	0·0437	....	....
	0·0445	0·0086	....
	0·0466	0·0095	0·0076
	0·0466	....	....
	0·0475	....	....
	0·0475	....	....
	0·048	0·0086	0·0067
	0·049	....	....
	0·050	0·0105	0·0086
	0·050	....	....
	0·052	0·0105	0·0086
	0·055	....	....
	0·056	0·0105	0·0086
Average ..	0·0413	0·0092	0·0073

Var. **linearis**, Mer., nov. var. (Pl. VIII. figs. 7–19.)

Diagnosis.—Valve narrow, linear or slightly attenuated at the ends, which are broadly rounded, never constricted in the middle. Girdle-face rather broad, quadrangular, slightly constricted, with round angles; extremities broadly truncate. Divisions of the zone terminating in marginal puncta, the four outer ones being very conspicuous. Length 0·015–0·053 mm. (average 0·037 mm.); breadth of valve 0·0048–0·0067 mm.; breadth of girdle-face 0·0095–0·012 mm., at the constriction 0·009–0·0095 mm.

Locality. Le Havre, North France (mar.); Black Sea, Crimea (Ialta, Sebastopol, somewhat brack. and mar.).

Of this variety I have seen a very great number of individuals in the Black Sea. In one gathering from Ialta (Crimea) I found it in an almost pure condition, with only occasionally a few specimens of the type species; in another gathering from Sebastopol it was the type species which predominated, only very few individuals of var. *linearis* being mixed with it. This shows that the var. *linearis* is really distinct, while intermediate forms prove it to be only a variety.

The valves are sometimes perfectly linear (figs. 10, 17), but as frequently, if not more, they are somewhat attenuated at the ends (figs. 7, 11, 15), the extremities being sometimes a little produced (figs. 13, 16); the ends are not truncate, as

in the type, but usually broadly rounded, never cuneate and so acute as in fig. 35, pl. xxvi., of A. Schmidt's 'Atlas.' The main distinction, however, between var. *linearis* and the type as regards their valves consists in the absence of any constriction in the middle of the valve.

The girdle-face presents a still greater number of distinctive features. It is broader, more quadrangular, the lateral margins are not so convex and the median constriction so marked; the extremities are more truncate. The longitudinal divisions of the zone terminate with a punctum, of which the four outer puncta, situated inside the terminal nodules, are very conspicuous. This latter characteristic, insignificant as it may appear, is nevertheless very constant and readily distinguishes var. *linearis* from the type species, which never has the above-mentioned four puncta. The size is also a little smaller, averaging 0·037 mm., instead of 0·0413 mm.

The following are some individual measurements: —

	Length.	Breadth of the frustule.	At the constriction.
	mm.	mm.	mm.
	0·015	0·0095	0·009
	0·016	0·0095	....
	0·02	0·0076	....
	0·02	0·0086	....
	0·024	0·0086	....
	0·031	0·0105	0·0086
	0·040	0·013	0·0105
	0·041	0·0114	0·0095
	0·041	0·012	0·0095
	0·041	0·017	0·0143
	0·0427	0·0105	....
	0·0427	0·0105	0·0076
	0·050	0·0105	0·0076
	0·050	0·012	0·0095
	0·052	0·0114	0·0086
	0·053	0·0114	0·0095
	0·053	0·012	0·0095
Average ..	0·037	0·0109	0·0095

If we compare the measures of the type species with those given by Cleve (length 0·05–0·140 mm.) we can clearly see that the form described by this author is not the same as that which has been figured by Peragallo and described by me. In all probability it represents a peculiar large variety, which ought to be distinguished as var. *major*. Peragallo,

speaking of such forms, says :—" Je n'ai jamais vu de grandes formes de cette espèce, signalée surtout dans l'Océan (Atlantic) et les mers arctiques, les petites formes telles que celles que j'ai dessinées sont peut-être spéciales aux mers chaudes " *. The locality of var. *major* would be, according to Cleve :— Davis Strait; North Sea.

Another variety seems to be the form figured in A. Schmidt's 'Atlas,' pl. xxvi. fig. 35. Valve linear, with cuneate, subacute ends, not constricted in the middle; stauros narrow, not reaching the margins. Girdle-face unknown. The girdle-face represented by fig. 36 is no doubt an *Amphora* (a form of *A. lævis* or *A. ostrearia*), and certainly has nothing to do with fig. 35. This variety, of unknown origin, may be named var. *cuneata*.

4th July, 1901.

EXPLANATION OF PLATE VIII.

[All figures are magnified 1260 times.]

Fig. 1. *Stauronella constricta* (Ehr.), Mer. A typical girdle-face.
Fig. 2. Ditto. A typical valve belonging to the same individual.
Fig. 3. Ditto. A double frustule.
Figs. 4, 5. Ditto. Both figures refer to the same individual.
Fig. 6. Ditto. One of the smallest individuals observed.
Fig. 7. *Stauronella constricta*, var. *linearis*, Mer. First type of valves (see also fig. 11).
Fig. 8. Ditto. A typical girdle-face, same individual as fig. 7.
Fig. 9. Ditto. Girdle-face belonging to the valve fig. 10.
Fig. 10. Ditto. Second type of valves, perfectly linear (see also fig. 17).
Fig. 11. Ditto. First type of valves (see also fig. 7).
Figs. 12–15. Ditto. Small individuals.
Figs. 16, 17. Ditto. Endochrome in the valvular aspect; *pr.*, *pr.*, pyrenoids.
Fig. 18. Ditto. Endochrome in the zonal aspect.
Fig. 19. Ditto. Diagram representing an ideal transverse section of a frustule along the line *a b* in figs. 17 and 18, and showing the disposition of the chromatophores; the dentitions on the zone-faces indicate the longitudinal divisions of the zone; *pr.*, pyrenoid.

All figures represent individuals from the Black Sea.

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* Peragallo, Diat. mar. d. Fr. p. 57.